REMARKS

Applicants submit this Preliminary Amendment to correct certain typographical errors that appear in the present application. Due to an apparent word processor translation/conversion error, some symbols were inadvertently misprinted in the application as filed. By this Preliminary Amendment, Applicants seek to substitute intended symbols in place of the misprinted symbols. This amendment essentially involves merely the substitution of symbols, the underlying equations and relations in which the symbols are used are fully supported by the specification, claims and figures of the instant application. In addition, the symbols being substituted and their associated equations were originally included and are fully supported by provisional application 60/308,587, to which the present application claims priority. Further still, the present application is one of five co-pending applications that were filed simultaneously and with essentially common disclosures. Three of the five co-pending cases were filed free of any typographical errors. For instance, all substituted symbols (in particular, symbols in connection with the description of FIG. 1d) are supported by co-pending application 10/050,529, having at least one common inventor with the present application. Applicants respectfully submit that this amendment adds no new matter, is fully supported by the instant and priority disclosures, and merely corrects typographical errors and, therefore, should be entered.

If the Examiner believes that a telephone conference or interview would advance prosecution of this application in any manner, the undersigned stands ready to conduct such a conference at the convenience of the Examiner.

It is believed that no fees are due in connection with the filing of this Preliminary Amendment. In the event it is determined that a fee is necessary to maintain the pendency of this application, the Commissioner is hereby authorized to charge or credit the undersigned's Deposit Account No. 50-0206.

Respectfully submitted,

HUNTON & WILLIAMS

Date: July 24, 2002

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ATTACHMENT A - MARKED UP VERSION WITH CHANGES

Paragraph beginning at line 14 of page 12 has been amended as follows:

FIG. 1d is an example of a timing diagram of an activation sequence. As illustrated, STUR may initiate Cr, lasting a duration of t_{cr}, which has a nominal value of 1 second with [!]$\pm$ 20 millisecond tolerance. Time from the end of Cr to a beginning of Sc is represented by t_{crsc}, which has a nominal value of 500 millisecond with [!] $\pm$ 20 millisecond tolerance. After a time t_{crsc}, STUC may initiate Sc. Time from the end of Cr to a beginning of Sr is represented by t_{crsr}, which has a nominal value of 1.5 second with [!]$\pm$ 20 millisecond tolerance. After a time t_{crsr}, STUR may initiate Sr. After Sc, STUC may initiate Tc. After Sr, STUR may initiate Tr. After Tc, STUC may initiate Fc. At approximately the same time, $Data_c$ and $Data_r$ may be initiated by STUC and STUR, respectively. Time from the beginning of Cr to the beginning of $Data_r$ is represented by $t_{Actdata}$, which has a nominal value of 15 seconds.

Paragraph beginning at line 25 of page 12 has been amended as follows:

If the SNR is calculated in the time domain, one method to determine PBO is according to the equations shown below.

$$SNR_{dB} = 10\log_{10}\left(\frac{P_{signal+noise}}{P_{noise}}\right) = 10\log_{10}\left(\frac{\sum_{n=0}^{M-1} |[s(n)+w(n)]|^2}{\sum_{n=0}^{M-1} |w(n)|^2}\right) \qquad (1)$$

$PBO_{dB} = SNR_{dB}$ - ([[illegible]]$\underline{\gamma}$ + [[illegible]“]$\underline{\delta}$ + SNR_{min})

(2)

$s(n) = n^{th}$ sample of the received signal
$w(n) = n^{th}$ sample of the received noise
M = window length in samples used to compute average
$P_{signal+noise}$ = power of signal + noise
P_{noise} = power of noise only

where [℘]$\underline{\gamma}$ represents a required margin in dB (≥ 0 dB, example: G.SHDSL Annex B margin is 6 dB); SNR_{min} represents a minimum SNR in dB needed to obtain the specified BER, and [ɑ]$\underline{\delta}$ represents an implementation loss in dB.

Paragraph beginning at line 18 of page 15, has been amended as follows:

Using the geometric mean, a SNR of the channel may be computed using the following:

$$SNR \cong \left[\left[\prod_{k=\alpha}^{\beta} \frac{|Y(k)-\hat{W}(k)|^2}{|W(k)|^2}\right]^{\frac{1}{\beta-\alpha+1}}\right] \quad (6)$$

$$SNR \cong 10\log_{10}\left[\left[\prod_{k=\alpha}^{\beta} \frac{|Y(k)-\hat{W}(k)|^2}{|W(k)|^2}\right]^{\frac{1}{\beta-\alpha+1}}\right] = \frac{10}{\beta-\alpha+1}\sum_{k=\alpha}^{\beta}\log_{10}\left[\frac{|\hat{S}(k)|^2}{|W(k)|^2}\right] \quad (7)$$

which may be rewritten in the following manner to filter cells with negative or zero SNR

$$D'_k = \log_{10}\left[\frac{|\hat{S}(k)|^2}{|W(k)|^2}\right] \quad (8)$$

$$D_k = \begin{cases} D'_k & D'_k > 0 \\ 0 & otherwise \end{cases} \quad (9)$$

$$SNR_{dB} = \frac{10}{\beta-\alpha+1}\left(\sum_{k=\alpha}^{\beta} D_k\right) \quad (10)$$

where 0 < [ɑ]$\underline{\alpha}$ < [℘]$\underline{\beta}$ < N-1; $\hat{S}(k)$ represents an estimate of kth frequency sub-band of a received signal spectrum; $\hat{W}(k)$ represents an estimate of kth frequency sub-band of a received noise spectrum; $Y(k)$ represents a kth frequency sub-band of signal plus noise spectrum; [ɑ]$\underline{\alpha}$

represents a starting sub-band; [℘]β represents an ending sub-band; D_k represents one or more sub-bands with SNR greater than zero; D'_k represents SNR for kth sub-band.

Paragraph beginning at line 13 of page 18 has been amended as follows:

Equation (15) is described in "The Fast Fourier Transforms and it's Applications" by E. Oran Brigham –1988 – equation 6.16, page 97.
The first cosine and sine terms may be found using the equations below.

$$R_0 = \cos\left(\frac{4\pi}{N_{real}}\right) \qquad (16)$$

$$I_0 = -\sin\left(\frac{4\pi}{N_{real}}\right) \qquad (17)$$

where

N_{real} = real FFT size

R_0 = zeroth sample of real part of exponential weight

I_0 = zeroth sample of imaginary part of exponential weight

The equations to recursively compute the transform weights are given below:

$$R_m = R_0\ [\exists]\underline{\cdot}\ R_{m-1} - I_0\ [\exists]\underline{\cdot}\ I_{m-1} \qquad (18)$$

$$I_m = I_0\ [\exists]\underline{\cdot}\ R_{m-1} + R_0\ [\exists]\underline{\cdot}\ I_{m-1} \qquad (19)$$

where m = 1, 2, $[\uparrow]\underline{\cdots}\ \frac{N_{real}}{4}$

$R_m = m^{th}$ sample of real part of exponential weight

$I_m = m^{th}$ sample of imaginary part of exponential weight

Paragraph beginning at line 1 of page 20 has been amended as follows:

Equations (18) and (19) may be modified slightly and then used with the above initializers to compute the new weights.

$$R_m = R_0\,[\exists]\,\underline{\cdot}\,R_{m-1} - I_0\,[\exists]\,\underline{\cdot}\,I_{m-1} \tag{28}$$

$$I_m = I_0\,[\exists]\,\underline{\cdot}\,R_{m-1} + R_0\,[\exists]\,\underline{\cdot}\,I_{m-1} \tag{29}$$

where $m = 1, 2, [\uparrow]\,\underline{\cdots}\,\frac{N_{real}}{2}$

Paragraph beginning at line 22 of page 21 has been amended as follows:

If the SNR is calculated in the time domain, a method to compute the capacity may include measuring the silence power (noise), P_{noise}, and then the received power (signal + noise), $P_{signal+noise}$, and finding the capacity, C, using the equation below.

$$C = B\log_2\left(1 + \frac{P_{signal}}{P_{noise}10^{\frac{(\Gamma - G + \gamma + \delta)}{10}}}\right) = B\log_2\left(1 + \frac{SNR}{10^{\frac{(\Gamma - G + \gamma + \delta)}{10}}}\right)\frac{bits}{second} \tag{30}$$

where Γ represents a gap from a theoretical channel capacity for PAM signals, in dB; G represents a coding gain of a Trellis decoder in dB; B represents a transition bandwidth; [℘]$\underline{\gamma}$ represents a required margin in dB (e.g., G.SHDSL Annex B margin is approximately 6 dB); and [☙]$\underline{\delta}$ represents an implementation loss in dB.

Paragraph beginning at line 23 of page 23 has been amended as follows:

Starting with equation (30) above, an overall capacity may be determined by summing capacities for each individual sub-band as shown by equation (33) below.

$$C \cong B_s \sum_{k=\alpha}^{\beta} \log_2 \left(1 + \frac{|Y(k) - \hat{W}(k)|^2}{|\hat{W}(k)|^2 \, 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}}} \right)$$

$$= B_s \sum_{k=\alpha}^{\beta} \log_2 \left(\frac{|\hat{W}(k)|^2 \, 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} + |Y(k) - \hat{W}(k)|^2}{|\hat{W}(k)|^2 \, 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}}} \right)$$

$$= B_s \left(\sum_{k=\alpha}^{\beta} \log_2 \left(|\hat{W}(k)|^2 \, 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} + |\hat{S}(k)|^2 \right) - \sum_{k=\alpha}^{\beta} \log_2 \left(|\hat{W}(k)|^2 \, 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} \right) \right) \quad (33)$$

where $B_s = \frac{B}{(\beta - \alpha + 1)}$; 0 < [α]$\underline{\alpha}$ < [β]$\underline{\beta}$ < N-1; B_s represents a sub-band width in Hz; $\hat{S}(k)$ represents an estimated "signal only" power; Γ represents a gap from a theoretical channel capacity for PAM signals, in dB; G represents a coding gain of a Trellis decoder in dB; [γ]$\underline{\gamma}$ represents a required margin in dB (e.g., G.SHDSL Annex B margin is approximately 6dB); [δ]$\underline{\delta}$ represents an implementation loss in dB, α represents an index of a first sub-band and β represents an index of a last sub-band.

Paragraph beginning at line 12 of page 29 has been amended as follows:

As shown in FIG. 7, an output of the precoder 710 may have an approximately flat power spectrum. Keeping this in mind while tracing the signal paths in the above block diagram, the following may apply:

$X(f)$ [{]$\cong K$ = constant (37)

$Y(f) = X(f)H_{txf}(f)H_{ec}(f) + T_f(f)H_c(f) + W(f)$ (38)

$Z(f) = X(f)H_{dec}(f)$ (39)

$E(f) = Y(f) - Z(f) = [H_{txf}(f)H_{ec}(f) - H_{dec}(f)]X(f) + T_f(f)H_c(f) + W(f)$

$= [H_{txf}(f)H_{ec}(f) - H_{dec}(f)]K + T_f(f)H_c(f) + W(f)$ (40)

where $R_e(f)$ is defined as $[H_{txf}(f)H_{ec}(f) - H_{dec}(f)]K$ wherein $R_e(f)$ represents residual echo spectrum, then $E(f) = R_e(f) + T_f(f)H_c(f) + W(f)$.

Paragraph beginning at line 23 of page 44 has been amended as follows:

The optimum shift points may be determined by software. The following table lists the gear-shift point in samples and the right shift (e.g., power of two) division of the weights. These gears may be used in the initial training. While in steady state, a single gear may be used and may be approximately ½ the smallest [③]$\underline{\mu}$ in the table.

Gear#	0	1	2	3	4	5
Samples	2000	598	1427	3188	7241	15000
Right Shift	3	4	5	6	7	8

APPENDIX B - CLEAN VERSION

Paragraph beginning at line 14 of page 12 as amended:

FIG. 1d is an example of a timing diagram of an activation sequence. As illustrated, STUR may initiate Cr, lasting a duration of t_{cr}, which has a nominal value of 1 second with ± 20 millisecond tolerance. Time from the end of Cr to a beginning of Sc is represented by t_{crsc}, which has a nominal value of 500 millisecond with ± 20 millisecond tolerance. After a time t_{crsc}, STUC may initiate Sc. Time from the end of Cr to a beginning of Sr is represented by t_{crsr}, which has a nominal value of 1.5 second with ± 20 millisecond tolerance. After a time t_{crsr}, STUR may initiate Sr. After Sc, STUC may initiate Tc. After Sr, STUR may initiate Tr. After Tc, STUC may initiate Fc. At approximately the same time, $Data_c$ and $Data_r$ may be initiated by STUC and STUR, respectively. Time from the beginning of Cr to the beginning of $Data_r$ is represented by $t_{Actdata}$, which has a nominal value of 15 seconds.

B1

Paragraph beginning at line 25 of page 12 as amended:

If the SNR is calculated in the time domain, one method to determine PBO is according to the equations shown below.

$$SNR_{dB} = 10\log_{10}\left(\frac{P_{signal+noise}}{P_{noise}}\right) = 10\log_{10}\left(\frac{\sum_{n=0}^{M-1}|[s(n)+w(n)]|^2}{\sum_{n=0}^{M-1}|w(n)|^2}\right) \qquad (1)$$

B2

$$PBO_{dB} = SNR_{dB} - (\gamma + \delta + SNR_{min}) \qquad (2)$$

$s(n) = n^{th}$ sample of the received signal
$w(n) = n^{th}$ sample of the received noise
M = window length in samples used to compute average
$P_{signal+noise}$ = power of signal + noise
P_{noise} = power of noise only

where γ represents a required margin in dB ($\geq$ 0 dB, example: G.SHDSL Annex B margin is 6 dB); SNR_{min} represents a minimum SNR in dB needed to obtain the specified BER, and δ represents an implementation loss in dB.

B2

Paragraph beginning at line 18 of page 15 as amended:

Using the geometric mean, a SNR of the channel may be computed using the following:

$$SNR \cong \left[\left[\prod_{k=\alpha}^{\beta} \frac{|Y(k)-\hat{W}(k)|^2}{|W(k)|^2}\right]^{\frac{1}{\beta-\alpha+1}}\right] \qquad (6)$$

$$SNR \cong 10\log_{10}\left[\left[\prod_{k=\alpha}^{\beta} \frac{|Y(k)-\hat{W}(k)|^2}{|W(k)|^2}\right]^{\frac{1}{\beta-\alpha+1}}\right] = \frac{10}{\beta-\alpha+1}\sum_{k=\alpha}^{\beta}\log_{10}\left[\frac{|\hat{S}(k)|^2}{|W(k)|^2}\right] \qquad (7)$$

which may be rewritten in the following manner to filter cells with negative or zero SNR

B3

$$D'_k = \log_{10}\left[\frac{|\hat{S}(k)|^2}{|W(k)|^2}\right] \qquad (8)$$

$$D_k = \begin{cases} D'_k & D'_k > 0 \\ 0 & otherwise \end{cases} \qquad (9)$$

$$SNR_{dB} = \frac{10}{\beta-\alpha+1}\left(\sum_{k=\alpha}^{\beta} D_k\right) \qquad (10)$$

where $0 < \alpha < \beta < N-1$; $\hat{S}(k)$ represents an estimate of k^{th} frequency sub-band of a received signal spectrum; $\hat{W}(k)$ represents an estimate of k^{th} frequency sub-band of a received noise spectrum; $Y(k)$ represents a k^{th} frequency sub-band of signal plus noise spectrum; α represents a

B3 starting sub-band; β represents an ending sub-band; D_k represents one or more sub-bands with SNR greater than zero; D'_k represents SNR for k[th] sub-band.

Paragraph beginning at line 13 of page 18 as amended :

Equation (15) is described in "The Fast Fourier Transforms and it's Applications" by E. Oran Brigham –1988 – equation 6.16, page 97.

The first cosine and sine terms may be found using the equations below.

$$R_0 = \cos\left(\frac{4\pi}{N_{real}}\right) \qquad (16)$$

$$I_0 = -\sin\left(\frac{4\pi}{N_{real}}\right) \qquad (17)$$

where

N_{real} = real FFT size

R_0 = zero[th] sample of real part of exponential weight

I_0 = zero[th] sample of imaginary part of exponential weight

B4

The equations to recursively compute the transform weights are given below:

$$R_m = R_0 \cdot R_{m-1} - I_0 \cdot I_{m-1} \qquad (18)$$

$$I_m = I_0 \cdot R_{m-1} + R_0 \cdot I_{m-1} \qquad (19)$$

where $m = 1, 2, \cdots \frac{N_{real}}{4}$

$R_m = m^{th}$ sample of real part of exponential weight

$I_m = m^{th}$ sample of imaginary part of exponential weight

Paragraph beginning at line 1 of page 20 as amended:

B5 Equations (18) and (19) may be modified slightly and then used with the above initializers to compute the new weights.

$$R_m = R_0 \cdot R_{m-1} - I_0 \cdot I_{m-1} \quad (28)$$

$$I_m = I_0 \cdot R_{m-1} + R_0 \cdot I_{m-1} \quad (29)$$

B5

where m = 1, 2, $\cdots \frac{N_{real}}{2}$

Paragraph beginning at line 22 of page 21 as amended:

If the SNR is calculated in the time domain, a method to compute the capacity may include measuring the silence power (noise), P_{noise}, and then the received power (signal + noise), $P_{signal+noise}$, and finding the capacity, C, using the equation below.

$$C = B\log_2\left(1+\frac{P_{signal}}{P_{noise}10^{\frac{(\Gamma-G+\gamma+\delta)}{10}}}\right) = B\log_2\left(1+\frac{SNR}{10^{\frac{(\Gamma-G+\gamma+\delta)}{10}}}\right)\frac{bits}{second} \quad (30)$$

B6

where Γ represents a gap from a theoretical channel capacity for PAM signals, in dB; G represents a coding gain of a Trellis decoder in dB; B represents a transition bandwidth; γ represents a required margin in dB (e.g., G.SHDSL Annex B margin is approximately 6 dB); and δ represents an implementation loss in dB.

Paragraph beginning at line 23 of page 23 as amended:

Starting with equation (30) above, an overall capacity may be determined by summing capacities for each individual sub-band as shown by equation (33) below.

B7

$$C \cong B_s \sum_{k=\alpha}^{\beta} \log_2\left(1+\frac{|Y(k)-\hat{W}(k)|^2}{|\hat{W}(k)|^2\, 10^{\frac{(\Gamma-G+\gamma+\delta)}{10}}}\right)$$

$$= B_s \sum_{k=\alpha}^{\beta} \log_2 \left(\frac{|\hat{W}(k)|^2 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} + |Y(k) - \hat{W}(k)|^2}{|\hat{W}(k)|^2 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}}} \right)$$

$$= B_s \left(\sum_{k=\alpha}^{\beta} \log_2 \left(|\hat{W}(k)|^2 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} + |\hat{S}(k)|^2 \right) - \sum_{k=\alpha}^{\beta} \log_2 \left(|\hat{W}(k)|^2 10^{\frac{(\Gamma - G + \gamma + \delta)}{10}} \right) \right) \quad (33)$$

B1

where $B_s = \dfrac{B}{(\beta - \alpha + 1)}$; $0 < \alpha < \beta <$ N-1; B_s represents a sub-band width in Hz; $\hat{S}(k)$ represents an estimated "signal only" power; Γ represents a gap from a theoretical channel capacity for PAM signals, in dB; G represents a coding gain of a Trellis decoder in dB; γ represents a required margin in dB (e.g., G.SHDSL Annex B margin is approximately 6dB); δ represents an implementation loss in dB, α represents an index of a first sub-band and β represents an index of a last sub-band.

Paragraph beginning at line 12 of page 29 as amended:

As shown in FIG. 7, an output of the precoder 710 may have an approximately flat power spectrum. Keeping this in mind while tracing the signal paths in the above block diagram, the following may apply:

B4

$$X(f) \cong K = \text{constant} \quad (37)$$

$$Y(f) = X(f)H_{txf}(f)H_{ec}(f) + T_f(f)H_c(f) + W(f) \quad (38)$$

$$Z(f) = X(f)H_{dec}(f) \quad (39)$$

$$\begin{aligned} E(f) &= Y(f) - Z(f) = [H_{txf}(f)H_{ec}(f) - H_{dec}(f)]X(f) + T_f(f)H_c(f) + W(f) \\ &= [H_{txf}(f)H_{ec}(f) - H_{dec}(f)]K + T_f(f)H_c(f) + W(f) \end{aligned} \quad (40)$$

where $R_e(f)$ is defined as $[H_{txf}(f)H_{ec}(f) - H_{dec}(f)]K$ wherein $R_e(f)$ represents residual echo spectrum, then $E(f) = R_e(f) + T_f(f)H_c(f) + W(f)$.

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The optimum shift points may be determined by software. The following table lists the gear-shift point in samples and the right shift (e.g., power of two) division of the weights. These gears may be used in the initial training. While in steady state, a single gear may be used and may be approximately ½ the smallest μ in the table.

Gear#	0	1	2	3	4	5
Samples	2000	598	1427	3188	7241	15000
Right Shift	3	4	5	6	7	8